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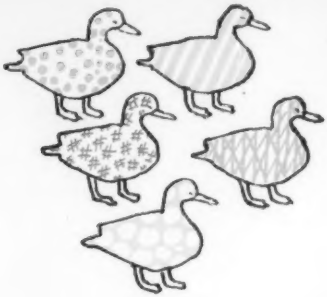


DNA-MODIFIED DUCKS

RECENT EXPERIMENTS in the transplantation of deoxyribonucleic acid (DNA) have produced wholly unexpected modifications in the physical structure of the host.

In an effort to determine whether DNA would cause genetic transformations from strain to strain in a single species of vertebrates, similar to those produced in micro-organisms, two breeds of domestic ducks, Pekin and Khaki Campbell, were selected. Pekin ducklings seven days old were injected with DNA from the genital cells and erythrocytes of male Khaki Campbells. It was expected that modifications might appear in the offspring of the injected Pekins, but what was not anticipated was that changes would occur in the physical characteristics of the DNA-injected ducklings themselves. Such changes did take place. Ducklings hatched as Pekins and treated with DNA from Khaki Campbell ducks grew into adult fowl with many of the characteristics of Khaki Campbells.

This work, presented before the Academy's Section of Biological and Medical Sciences, was performed by Drs. J. Benoit, P. Leroy, R. Vendrely, and C. Vendrely. The investigators reported that the changes that occurred in the body and head shape of the injected ducklings were no less than "astounding." Their observations again raise the question of the certainty ". . . that a living being is irrevocably determined at the time of conception. Is it not possible that an adequate agent introduced at the right time in an experimental way

could give a new direction to the evolution of the whole organism?"

In the case of the seven-day-old Pekin ducklings, injections of Khaki DNA produced ". . . phenotypical characteristics that no longer resemble those of their original breed, those of other known breeds of *Anas platyrhyncha,* or of known hybrids between breeds. These modified birds transmit their new characteristics to their progeny as far as the third generation."

DNA Responsible

Some critics of the DNA-duckling experiment have suggested that the modified ducks were natural hybrids; others have proposed the possibility that a "wandering gene" may have operated in the transformations, or that some mutation occurred. But the only hypothesis that appears tenable is that the injected DNA was the causative factor in the changes. Genetic contamination by other means seems improbable. The mode of action of the DNA, assuming it was responsible for the physical changes, is not clear, but it would seem to spread its effects throughout the organism in a coordinated and consistent manner.

The Benoit group has been unable to duplicate the original results in subsequent experiments, but many explicable factors may lie at the source of this inconsistency. Attack upon the problem by biochemists, geneticists, statisticians, serologists, and immunologists may produce its resolution, and vastly increase knowledge of the structure and functions of nucleic acids.

Pekin to Khaki

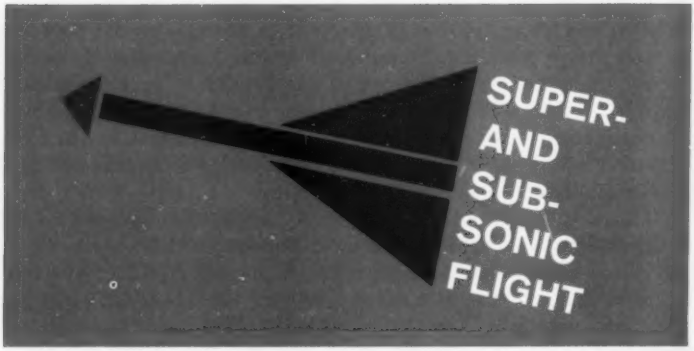
The investigators listed the following changes induced in the Pekin ducklings by the Khaki Campbell DNA: "Head and body. As distinguished from the Pekin duck, which has thick cheeks and a domed skull, the treated ducks develop a refined head with a flattened skull, not as globular as that of the Pekin. The body is curiously reduced, less upright, and more slender; the abdomen does not sag. The weight varies between 4 to 5 lbs. whereas that of the Pekin is between 8 to 9 lbs.

"Because of its completely discolored tint and its external appearance, the plumage of the treated duck no longer has the characteristics of the Pekin."

"Bill. Two modifications appeared. First, four of the nine females

treated lost the orange-yellow color so characteristic of the bill of a Pekin. If sometimes the tint of the bill was more or less pale in the female Pekin because of a vitamin deficiency at the end of the laying season, it remained nevertheless constantly yellowish. On the contrary, in the four treated females the carotenoids of the bill completely disappeared, and the bill took on a pinkish tint similar to that found in certain common breeds, for example, the Aylesbury or the Merchtem."

Other modifications appeared in the pigmentation of the webs of the treated ducklings ". . . of a particular pattern quite different from the more homogeneous stains found on some controls." □□



THE GROWING national avidity for quantities of supersonic aircraft would appear to reflect irrational anxieties in certain aspects of the present push for technological advances.

Bo Lundberg has urged a 20-year postponement of large-scale supersonic adventures. He would have that period used for exploiting the potentialities of V/STOL (Vertical and Short Take-off and Landing) aircraft, the development of low-cost subsonic flight, and adequate safety measures. Something might also be done during these years to overcome sonic booming and cosmic radiation hazards.

As an indication of the seriousness of the problem of sonic booming, he has stated that a 180-ton supersonic airliner of Mach 2 or 3 flying at 70,000 feet with a load of 100 passengers or equivalent cargo would create a band of sound on earth some 70 miles wide, often strong enough to break windows along the full supersonic flight path. "Never before in history," Lundberg wrote in the *New*

Scientist, "would so many have been disturbed so much by so few!"

Apart from the problems of sound levels, he stated, it is essential we make certain that "harmful biological – in particular genetic – effects due to cosmic radiation at the 'supersonic' altitudes are nonexistent. It would not be sufficient if an increasing number of medical experts were to state that they *believe* the danger is probably negligible."

D. C. Hazen, writing in the *American Scientist,* calculates that the sonic boom band on earth will be somewhat narrower than Lundberg estimates, but concludes that within the band "the sound level will range anywhere from unacceptable to catastrophic."

Hazen agrees that there is much yet to be done in the subsonic flight field, not the least of which is the "simple" matter of landing a modern 707 or DC-8. These craft touch down at 120-140 mph and take off at nearly 200 mph. "In many cases," Hazen remarks, "the take-off of a fully loaded transcontinental or transoceanic jet aircraft, although not so advertised by the airlines, remains something of an adventure." Concurring with Lundberg on another subsonic flight issue, Hazen calls for development of V/STOL especially for medium- and short-range air transportation that will provide a reasonable total-trip-time:distance ratio.

Lundberg believes that "forty to fifty years from now commercial and general aviation – including private flying – all over the world could have a volume in passenger miles some 50 to 100 times the present world volume (excluding Russia and China)." But he also points out that if the present air fatality rate per mile flown is not reduced, the volume of air traffic at that time would produce an intolerable 100,000 deaths per year.

Goals Differ

Despite the loudly voiced opinion that research and development on commercial supersonic aircraft is premature, participants in the Anglo-American Aeronautical Conference (held in London) assumed production will go ahead quickly. Basic differences in engineering approaches are argued along national lines: The British want to get on with the immediate development of aircraft with a potential speed of Mach 2.2. This would minimize design problems, and probably mean that such carriers could be put into service in about six years. Americans want designs capable of Mach 3 speeds, which would require an additional three or four years to put into the air,

would be more costly, but would also have more relevance to future higher speed designs.

A great deal of money will have to be spent on development, whether the plane be Mach 2.2 or Mach 3 – but the problems are so different that the costly engineering for Mach 2.2 will have little applicability when planes with speeds greater than Mach 3 are desired. Since the Mach 3 airliner, however, would be a forerunner of planes with even higher speeds, its engineering would be utilized in their construction.

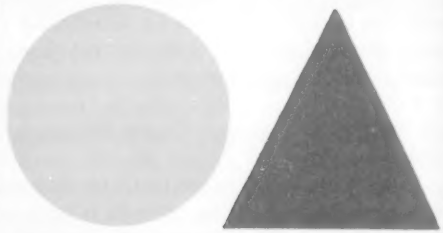
Both Arguments Valid

The British, while accepting the validity of the American view, maintain that there is not much difference in total trip-time for the traveller between Mach 2.2 and Mach 3. They also point out that Mach 2.2 should be good for a minimum of 10 years, during which time their operation will more than recover research and development costs.

American supersonic plane designers anticipate a delta-winged craft with a long projecting nose to which will be attached a smaller delta wing for control. The British would also make use of the delta wing, but there the design similarity ends.

As yet, neither side is wholly committed to its projected design, and possibly not to proceeding independently. □□

COLLEGE GUIDANCE PROGRAMS



The purpose of guidance programs for college students, it is generally agreed, "is to encourage the optimum development of each individual while recognizing his worth and dignity as a human being," according to a paper read before The Academy by W. M. Wise, of Teachers College, Columbia University.

Efforts to measure the effectiveness of such programs reveal a mixed student reaction to the services and functions offered by col-

lege personnel, and, as R. E. Iffert had reported in an earlier paper presented before the Academy's Division of Psychology, students judged guidance programs as less useful than the instructional ones.

Problems

While Prof. Wise recognizes the importance of student opinion of these programs, he believes that they offer "only oblique evidence with respect to the evaluation of the program itself. On the other hand, the assessment of the effects of specific techniques, although useful, seems inappropriate when viewed in relation to the total diversity of a college student body and in relation to the total guidance program."

Attempts have been made to evaluate guidance programs, including specific services, by comparing the purposes and function with student needs over a range of vocational and educational planning, personal problems, and interpersonal relationships. These studies have not provided a rigorous evaluation of the programs.

Present Limitations

R. Berdie and other investigators obtained inconclusive results in efforts to measure the value of specific techniques, particularly those calculated to help students solve problems, and reduce anxiety and defensive reactions. R. Strang has observed that research in college guidance programs is severely limited because "1) there is a lack of specific criteria; 2) there is a lack of scope in the studies; 3) there is a lack of longitudinal approach; and 4) the data tend to be mass data or group data and not studies of individuals." Strang concluded that "We need a theoretical framework that takes into account this complex of forces and factors: the individual student's drives and actions, the influence of his behavior on the group, the group's influence on him, and the other forces of the campus and community that help to determine his personal and social development."

Wise believes that to establish the reduction of anxiety as a criterion for measuring the effects of counseling "seems to assume a monolithic character of college students with respect to the role of anxiety in their personal lives." He pointed out that while the reduction of anxiety is a desirable counseling goal for certain students, the induction or heightening of anxiety might be more appropriate in others.

In developing effective research to measure counselling programs, Wise suggested that the student behavior that offers the most promising criteria for evaluation is that behavior involved in making decisions. "Choices concerning such factors as the curriculum, vocational and educational planning, and responses to social situations describe the individual human being as he is developing into maturity and they have a very large ingredient of the individuality so important in guidance. . . ."

For Many, Not One

Wise reviewed theory and experimental findings in decision making and concluded that "The major contribution of decision theory up to this point has been to illuminate the qualities of best decisions when the interests of many individuals are at stake, as, for example, in the economic decisions of government."

Fidelity to the stated purpose of college guidance programs ". . . has almost none of the dimensions of the decisions that are best for large groups of individuals." He cited the distinction made by Cronbach and Gleser in their recent exploration of psychological tests and decision theory between "what can be termed institutional decisions which have to do with the *best* choices for groups of individuals, and individual decisions, which have as their paramount interest the individual's desires and values." These investigators found that institutional decisions made by individuals are substantially different from those affecting personal desires.

New Premises

Wise stated that a problem "in using classic decision theory is that the so-called pay-off functions (that is, utility) are not very applicable." He proposed the feasibility of a description of "goodness" regarding student decisions that would be consistent with both cultural values and the more specific ones of higher education. The tentative list of characteristics he offered as a basis for testing the "goodness" of individual student decisions was as follows:

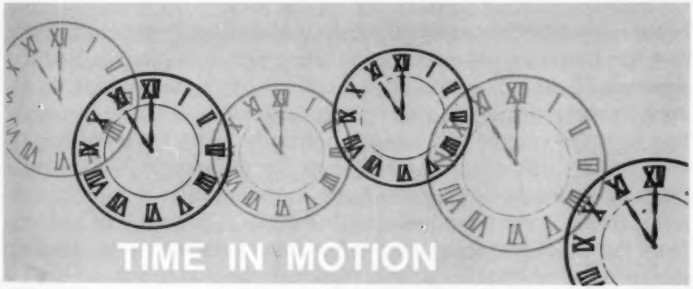
"1) The use of meaningful informational items including expectancy and probability data derived from testing, and reality data in terms of planning vocationally and educationally would provide a scale by which one could characterize the 'goodness' of individual decisions by students." Thus, the student who ignored informational

items wholly would not be making a good decision. If he relies wholly on informational items, the decision does not have an individual quality.

2) Student willingness to deal with ambiguity in the factors from which decisions are to be shaped, and without a basis for comparing the utility of decisions made with those rejected, other than his own values. Wise sees such "recognition of uncertainty and lack of assurance of attainment" as "consistent with the reality of the human situation in our society and with the purposes of higher education."

3) A good decision at a given moment would be one in which the individual is conscious of the nature of past and the possibilities of future choices, as well as current limitations. Thus, each such decision would be related to the realities of the past, and the student's judgment of the possibilities of the present and future.

4) Wise sees as "perhaps the most important characteristic that would determine 'goodness' of individual decision" student acceptance of the "recognition that individual decision is an expression of personal choice or preference," because this would seem "related to the ability of the student to . . . recognize that his future to some extent lies in his own hands." □□



THE ERA of relativity-testing, now forty years old, has not ended yet. Some recent experiments devised to test the predictions of Special and General Relativity in regard to time were described by Prof. Harry Lustig before the Academy's Section on Physical Sciences. According to these comprehensive mathematical representations of events, the structure of reality should be such that time is altered (a) when the timepiece and an observer are in accelerated motion relative to each other and, since (as the theory holds) accel-

eration of motion and acceleration of gravitation are indistinguishable, (b) by differences in gravitational potential.

Since nuclei of excited atoms oscillate – the radio-isotope iron^{57}, for example, at 3×10^{18} cps – they may be considered fast-ticking clocks, and their periodicity should undergo a change in accordance with the mathematical principles of relativistic mechanics. Of course, no direct measurement of a billion ticks per second can be made, except, theoretically, with another clock that would tick, say, 1,000 billion times per second. But the oscillations of atomic nuclei are the highest frequencies known, and therefore the best feasible measurement of them must be with themselves.

The phenomenon of nuclear resonance makes this measurement of time possible. If excited nuclei of iron^{57} (again as an example) are emitting photons or quanta of energy at their peculiar rate, then unexcited iron^{57} atoms located so as to receive the quanta emanating from the former group will absorb the radiation and themselves begin to oscillate and emit quanta. The frequency of emission and absorption is unique for each atomic isotope.

Indication of Change

For the purposes of relativity experiments, if resonance is established in the absorber nuclei and then ceases, the experimenter knows that the frequency of emission or absorption has altered. In effect a change in the rate of ticking is detected by the diminution or disappearance of ticking. A meter placed behind the absorber in a direct line with the emittor will register a drop in radiation when the absorber is actually absorbing radiation (in resonance), and a meter placed to one side will register a rise in radiation as a result of scattering from the newly excited absorber nuclei. The degree of variation from the exact frequency that will maintain resonance is called the sharpness of resonance, or the (spectral) line width. Resonance is said to occur if the energy lines of emittor and absorber overlap within their widths.

Recoil

But the situation is not quite as simple as that. It had been known for some time that excited atomic nuclei oscillate, emit quanta until they return to the ground (unexcited) state, induce resonance in identical nuclei, and so forth. Until recently, however, efforts to use

this effect for the study of physical questions were frustrated by inability to control the frequency of emission (and absorption). Difficulties arose from the fact that not unlike rifle fire, atomic nuclear emission involves loss of some of the projectile's energy to the emitting source, i.e., recoil. A similar loss occurs at the absorption end, just as the impact of a bullet on a target costs bullet-energy. Quanta do not lose or gain velocity – since they are equivalent to light – but instead lose or gain energy in the form of changes in intrinsic energy, or frequency (interchangeable terms in the quantum world). Alterations of energy would thus be useful in the tests of relativity.

Mössbauer Effect

About two years ago, R. L. Mössbauer found a means of eliminating natural recoil. Mössbauer embedded excited nuclei (he worked with iridium[191]) in rigid crystals whose elasticity was further reduced by cooling them to the temperature of liquid air. The entire experimental apparatus was mounted on rigid equipment nailed to the floor. Thus the inertia difference between projectile and "rifle" was so great that virtually zero energy was transferred from the former to the latter. (P. B. Moon and A. Storruste had done nearly equivalent work seven years before, but achieved only compensation where Mössbauer achieved elimination of recoil). When resonance is established in the Mössbauer setup, a very slight movement of the source of quanta with respect to the absorber alters the frequency sufficiently to destroy the resonance. Planned elimination of resonance is obtained by putting the emittor nuclei on a phonograph turntable, lathe, or other simple moving mechanism. Subsequent work, with iron[57], showed that resonance could be erased by moving the source at a speed as low as 50 mm per minute.

Wave Fronts and Train Whistles

These experiments are comparable to inducing Doppler effects. Moving one clock (timepiece) away from or towards the other clock (observer) causes the wave front (to use the nonquantum terminology) to be, respectively, stretched out or compressed, thereby effectively decreasing or increasing the frequency of the received electromagnetic signal. The Doppler effect is commonly exemplified in the rise in pitch of a train whistle as the train approaches the listening observer and the fall in pitch as the train moves away again.

Numerous other problems, features, and experimental gains from utilization of recoilless nuclear resonance, as well as certain aspects of the Doppler effect, the transverse Doppler effect, and the magnetic phenomenon of hyperfine splitting need not be explored here. In regard to relativistic time, however, the Mössbauer Effect was utilized in the following ways:

Special Relativity says that a clock ticks less often as observer and clock accelerate away from each other and more often as they accelerate towards each other. A standard example has a dispatcher and a conductor at a railroad station, their watches synchronized. The conductor leaves on a train, with his watch; the dispatcher remains at the station with his watch. If, as the train recedes from the station, each man were to observe the other's watch, he would conclude that it was running slow, or that his own was running fast, or, perhaps, both were off.

But for quanta, in effect we should expect a change in frequency (or energy) with this relative motion, and indeed if nuclear source and absorber are in relative motion – with one at the edge of a turntable and the other at the center – they are no longer in synchrony and resonance is erased. There is no way to determine which nuclear clock is out of synchrony with which. All that can be said is that the accelerated relative motion produces a "detuning," destroys resonance, or, precisely, shows the relativity of time.

The Test

The question in General Relativity concerns the principle of equivalence – that there is no way to distinguish between the accelerations of gravitational fields and inertial forces of motive acceleration. Hence synchrony should be destroyable merely by establishing a difference in gravitational potential acting on a clock distant from the observer and one right by his side. R. V. Pound and G. A. Rebka set up a recoilless nuclear resonance experiment (with iron^{57}) in which the source of quanta was some 20 meters (six stories) higher than the absorber.

Pound and Rebka did find that detuning occurred because one clock was in a region of higher gravitational potential than the other. Repeat experiments will certainly be done, but the Pound-Rebka results do not seem to be refutable; they confirm the principle of equivalence, the foundation stone of General Relativity and a major segment of all modern physics. □□

...in brief....

The control of present aircraft in and around crowded airports is one of the most difficult problems facing civil aeronautics authorities and engineers. Facilities do not increase as rapidly as do requirements, and the boom in air travel is outpacing the development and installation of traffic safety measures.

The Hughes Aircraft Co. has developed an application of radar that is intended to reduce the likelihood of flight collision. Existing radar units in airport control rooms cannot distinguish an actual from an apparent collision course. Considerable time and effort must be spent in determining whether the planes are on safe courses, and then maintaining that safety. This draws attention from other areas where, in fact, the observer's attention may be more necessary.

"Electronic Industries" reports that Hughes' new radarscope is really a screen on which the images of two radarscopes are projected. To the casual observer this appears to be but one screen – but the radar observer wears polaroid glasses, and the two scopes are projected through polaroid screens after a visual parallax has been introduced. The result is a 3-D view of the situation in which the differences or similarities in altitude of any two planes are immediately perceptible.

The tsunami set up by the Chilean earthquake of May 22, 1960, afforded R. Green, of the Geology Department of the University of Tasmania, with a means for measuring the average depth of the Pacific Ocean between South America and Tasmania.

The tsunami left the Chilean coast at 19 hours 11 minutes and 20 seconds Greenwich Mean Time and arrived at Hobart 12 hours later. From this, Green calculated the average ocean depth between Hobart and Chile to be 5,500 meters. To reach Auckland, New Zealand, the tsunami required 14 hours and four minutes, although Auckland is closer to the Chilean coast. The difference in time is attributed to the slowing of the wave by the long reach of shallow water over the continental shelf which extends out from New Zealand. □□

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